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OPERATING INSTRUCTIONS FOR THE GAMMA-BETA RAY SURVEY METER

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OPERATING INSTRUCTIONS FOR THE GAMMA-BETA RAY SURVEY METER*

By O. G. Landsverk

The gamma-beta ray survey meter is a portable electrometer instrument suitable for measuring gamma and beta radiations. It has been described in CP 1930.

TO OPERATE AS A SURVEY METER

1) For low rates of radiation, the toggle switch should be to the left. For rates above 50 milliroentgens per hour, throw the switch to the right. This permits making a reading in about 1 1/2 seconds in localities where radiation is intense.

2) In use, the meter is held in the left hand by placing the fingers under the case and depressing the left hand push button with the thumb. This action illuminates the microscope field. The left hand push button is held down during steps 3, 4, and 5.

3) Adjust the fiber to zero with the potentiometer.

4) Now grasp the meter firmly in both hands. Depress and hold the right hand push button down with the thumb. This releases the fiber from the charging potential. Simultaneously, a preliminary discharge of the neon bulb puts the timing circuit into operation.

5) The position of the fiber on the scale at the next flash of the neon lamp gives the rate of radiation directly in milliroentgens per hour. If the short time interval is used, the scale reading is multiplied by ten. Successive measurements may be made without changing the position of the hands, provided the zero adjustment is not disturbed. The fiber will shift somewhat on the scale if the meter is tilted. This fact can be utilized to make small adjustments of the fiber to zero without resort to the potentiometer. On the other hand, it requires that the instrument not be tilted appreciably while a measurement is being made.

6) The first scale range goes from 0 to 100 milliroentgens per hour. This scale departs from calculated gamma-ray rates by not over two per cent at any point. The normal error in reading this scale is 1/2 milliroentgen per hour. The second scale also starts from zero. Its useful range extends from about 50 to 1000 milliroentgens per hour, the maxium reading. In the range from 50 to 1000 milliroentgens per hour, the maxium error from calculated rates is usually less than three per cent. This scale can be read with an error of about 5 milliroentgens per hour. The meter will show about 10% collection loss at 2 roentgens per hour.

7) The error due to the built-in timer can be held to an insignificant value for survey work if a simple precaution is taken: Before starting a series of readings, the timer circuit should be discharged by depressing the right hand push button once or twice. This serves to remove perhaps eighty per cent of the residual charge in the paper condenser. It also eliminates the error due to a tendency of some neon lamps to have an initial flashing potential that is higher than normal after a prolonged rest period.

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The same elimination of error is secured if the first reading of a series is discarded. Errors are also minimized if the condenser is allowed to recharge for three or four seconds between measurements by releasing the push button.

8) The sensitivity of the electrometer will not change unless it is jarred so the geometry of its elements is changed. It is, therefore, a simple matter to recalibrate these meters by resetting the timer to the interval which was found to be proper in the original calibration which is furnished with the meter.

It is, of course, desirable to recheck the calibration against a known source of gamma radiation at intervals of several months. In doing so, the most accurate result can be had by using a source of 25 to 100 milligrams of radium and using a rate of 30 to 75 milliroentgens per hour rather than the conventional 12 1/2 for adjusting the time constant of the low rate range of the meter. This introduces no observable error for low rates and has obvious merit in securing overall accuracy.

A known rate of radiation in this range of intensity is allowed to traverse the ionization chamber. The meter is then operated in the usual fashion as a survey meter and the left hand potentiometer is adjusted so that the meter indicates correctly the known rate.

Once the time constant for low rates has been adjusted in this manner, the calibration for both ranges will be the same as that which was furnished with the meter unless the geometry of the electrometer has changed due to jarring or other causes.

9) Beta rays can be measured by opening the sliding door at the front of the case. The ionization chamber is fitted with a one mil thick celluloid window. This will stop all but the very high energy alpha particles but will admit at least a high percentage of the lowest energy beta rays that are biologically effective. Should the windows loosen at the edges, zapon (carbonoid A) or any lacquer makes a good cement. Zapon has the advantage that it is conducting.

TO OPERATE AS A LABORATORY METER

1) Place the instrument on a vibration-free support.

2) Set the fiber to a position that is slightly above the desired starting mark. Lock the right hand push button in the depressed position by a slight clockwise rotation. This also locks the microscope light switch in the closed position. A stop watch may now be conveniently employed for accurate measurements. As noted, the scale is very nearly linear for any given rate of radiation. However, slightly higher accuracy is obtained if the same portion of the scale is used at all times, and if the sources of radiation are so placed that their rates at the meter are nearly equal.

SERVICING

1) To remove the instrument from its case, remove the carrying strap and the four corner cover screws. The entire mechanism, which is integral with the cover, may then be slid out of the case. When replacing the meter, first place the batteries in the back of the case, jam the sponge rubber pad between the batteries and the case, and fold the cable over the batteries as the instrument is slid back into place. Take care that the battery cable does not touch the lead to the charging rod since this may cause erratic behavior of the fiber when the voltage is connected to it.

2) The last 22 1/2 volts of the "B" battery are connected permanently across the ten megohm potentiometer. This insures that the fiber is always at equilibrium at or near its operational range. The drain is negligible, so the batteries should have shelf life. They are readily replaced by the use of a soldering iron.

3) Two No. 2 flashlight cells in parallel are connected to a two-cell self-focusing bulb for the microscope light. The cells are held in convenient clips for easy replacement. They should last about three months in survey work. The microscope light is turned on from either push button switch.

4) Experience has shown that, at least in normal use, the electrometer fiber will not become entangled with other parts. However, should this happen, the fiber can be freed with negligible probability of damage if these suggestions are followed:

a) Try first to rap the case or the ionization chamber sharply with a light object. (Note: The voltage must be disconnected from the fiber when it is to be freed. This is most conveniently done by locking the right hand push button.);

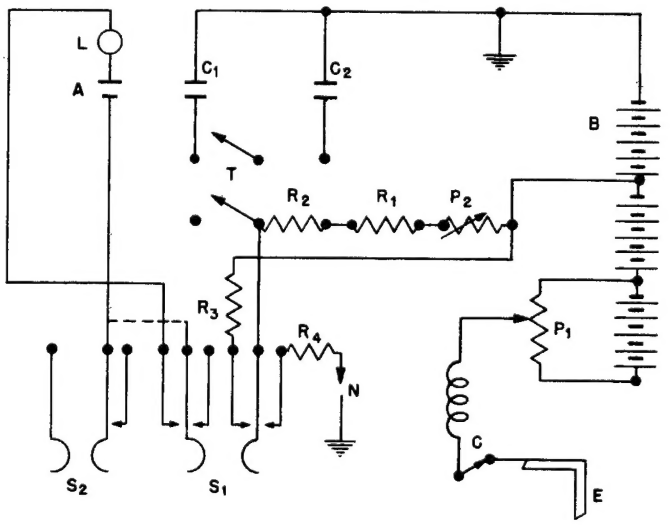
b) To remove the ionization chamber, remove the two small screws that hold the chamber to its cover. Be careful that the chamber does not fall off as this would likely damage the electrometer;

c) To prevent touching the electrometer when the chamber is removed, the chamber should be moved in a line parallel to its own and the microscope axis until it clears the electrometer assembly;

d) Do not attempt to work on the electrometer fiber without first determining its exact condition with a 4 to 10 power magnifier. Intense illumination and a background of black velvet are a great help in viewing the fiber;

e) Do not touch the fiber with any instrument. This is hazardous and is not necessary. A gentle puff of air from the appropriate direction is all that is required. Experimental fibers have been freed dozens of times consecutively by this method without damage;

f) Check to see that the fiber is free just before replacing the chamber. This is conveniently and safely done by laying the meter on its side on a smooth horizontal surface. Place the chamber near-by so that it is ready to be slid into place. The chamber then serves as a shield against air currents, while the position of the fiber is checked and the chamber replaced.



A – Two 1 1/2-volt No. 2 cells in parallel
B – Three small 45-volt batteries
C – Electrometer contact switch (opened by depressing S_1)
C_1 – 1.0 μf condenser
C_2 – 0.1 μf condenser
E – Electrometer
L – No. 222 Mazda 2.2 v bulb
N – 1/25 watt glass base neon bulb
P_1 – 10 meg electrometer adjuster pot
P_2 – 10 meg variable timer resistance
R_1 – 20 to 60 meg fixed timer resistance
R_2 – 0 to 10 meg double range synchronizing resistance
R_3 – 1 meg protecting resistor
R_4 – 0.2 meg protecting resistor
S_1 – D.P.D.T. push button switch
S_2 – S.P.S.T. push button switch

Figure 1. The circuit.

5) Do not slide the microscope tube up or down or turn it. No good is accomplished thereby, and the neon lamp may be damaged or shorted out. The microscope is focused inside the chamber by turning the objective lens holder in the microscope barrel.

6) When properly adjusted, there is only a small, if any, displacement of the fiber just as it is released from the charging voltage. This is because the change in capacity of the electrometer, due to removing the charging wire, has been compensated for by suitable geometry of the charging wire. The displacement should not exceed 1/2 milliroentgen equivalent when the push button is fully depressed. The exact adjustment is made by trial and error. If for any reason it becomes annoyingly large, it may be reduced as follows: If the auxiliary wire (not the contact wire) is bent closer to the contact arm of the electrometer, the fiber will lose voltage when the push button is depressed and vice versa. This may, of course, be used to cancel out a pre-existing gain or loss in voltage. (It is obvious that the auxiliary charging wire is not superfluous as it might appear at first glance. It must under no circumstances be removed.)

7) If the image of the fiber becomes fuzzy or has colored fringes at the ends of the scale, this may be remedied by adjusting the screw which is located externally in the center of the bottom of the ionization chamber. This screw controls the position of the cylindrical concave reflecting mirror that supplies light to the microscope field.

8) Should it be desired to refocus the microscope it is necessary to remove the ionization chamber so the knurled shoulder of the objective lens holder may be turned. To check the focus, replace the chamber and view the fiber near the center of the scale.